UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	HIGHWAY ENGINEERING
COURSE CODE	:	BFC 3042 / BFC31802
PROGRAMME	:	BFF
EXAMINATION DATE	:	JUNE 2012
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **THIRTEEN (13)** PAGES

Q1 (a) List the material which typically used to construct the following flexible pavement layer.

(i) Sub-grade

(1 mark)

(ii) Sub-base

(1 mark)

(iii) Road base

(1 mark)

(b) Flexible pavement used the asphalt concrete mixture to construct the surface layer.

(i) Name the flexible pavement surface layers.

(2 marks)

(ii) List the materials that been used to produce the asphalt concrete mixture.

(4 marks)

(c) There are several types of bitumen that typically been used as a binder in the asphalt concrete mixture namely penetration, cutback and emulsion bitumen. Recently, emulsion bitumen become more popular in asphalt mixture production industry. Give your justifications why emulsion bitumen becomes more popular.

(4 marks)

(d) Asphalt concrete mixture of AC14 will be used to construct the wearing course layer. Prior to the production of the mixture, the blending of aggregate need to be performed and must fulfill the gradation limit according to the specification as shown in Table 1. Table 2 shows the result of sieve analysis test for the blend aggregates. Conduct the analysis of the test result and give your justification either the gradation of the blend aggregates comply or not to the specification.

(12 marks)

Q2 (a) List and explain **FIVE (5)** disadvantages of concrete pavement

(5 marks)

(b) A plain concrete rigid pavement, doweled joint and concrete shoulders is designed for a two-lane two-direction road. Accumulated number of axle load during the design period is shown in Figure **Q2.**

Given:

Modulus of subgrade reaction (k)   = 40   MPa/m
Concrete Modulus of Rupture (M_R) = 4.5 MPa
Safety factor LSF   = 1.0
Slab thickness   = 240 mm

Using nomograph and tables (PCA method), complete the calculation form as shown in Figure **Q2** and determine:

(i) Percentage of fatigue.
(ii) Percentage of damage cause by erosion.
(iii) Compare the percentage of fatigue and erosion, give your comment and justification.

(20 marks)

Q3 (a) Clarify in detail the importance of having site investigation within road construction process.

(12 marks)

(b) If it is necessary to built roads over weak soils, efforts must be made to improve the poor sub-grade. Briefly explain **THREE (3)** of such efforts.

(6 marks)

(c) Compaction is an important process in the preparation of the road surface.

    (i)   Describe what does compaction do to the Hot Mix Asphalt (HMA) layer?

(2 marks)

    (ii)   List **TWO (2)** pavement distresses which may occur due to inadequate compaction

(2 marks)

    (iii)   Name **THREE (3)** types of compaction equipment which are commonly used and mention their function in the construction of asphalt concrete.

(3 marks)

3

Q4 (a) Differentiate the criteria of selection for rehabilitation work between full depth reconstruction and partial depth reconstruction.

(6 marks)

(b) Give **THREE (3)** factors that influence the selection of binder for design chip seal

(3 marks)

(c) Lists the activities that includes in Pavement Management System (PMS).

(4 marks)

(d) Table **3** shows a pavement condition survey for sample unit section JPB-KM2 of Jalan Universiti. By using Figure **Q4 (a)** and **Q4 (b)** together with the sample area of 600 m^2, completely fill in the Table **3**. Then, determine the Pavement Condition Index value of the surveyed area if the maximum corrected deduct value is 65.

(12 marks)

Q5 (a) Figure **Q5** shows the flexible pavement structured by asphaltic concrete for first layer and granular material for drainage layer. Refer Figure **Q5** and answer the following questions.

(i) Name **TWO (2)** sources of subsurface water as notes as A and B.

(2 marks)

(ii) Lists the factors that influence the quantity of source A. Give **TWO (2)** of it

(4 marks)

(iii) Can very fine aggregate soil be used as a drainage layer and why?

(4 marks)

(iv) Give **THREE (3)** factors that influence the determination of the subsurface pipe drain size and spacing.

(6 marks)

(b) Describe briefly how typical surface drainage maintenance is conducted.

(9 marks)

S1   (a)   Senaraikan bahan yang lazimnya digunakan untuk membina lapisan turapan lentur berikut.

        (i)   Sub-gred

(1 markah)

        (ii)   Sub-tapak

(1 markah)

        (iii)   Tapak jalan

(1 markah)

    (b)   Turapan lentur menggunakan campuran konkrit berbitumen untuk membina lapisan permukaan.

        (i)   Namakan lapisan permukaan turapan lentur.

(2 markah)

        (ii)   Senaraikan bahan-bahan yang digunakan untuk menghasilkan campuran konkrit berbitumen.

(4 markah)

    (c)   Terdapat beberapa jenis bitumen yang lazimnya diguna pakai sebagai pengikat di dalam campuran konkrit berbitumen seperti bitumen penusukan, 'cut-back' dan emulsi. Kini, bitumen emulsi lebih banyak digunakan di dalam industri campuran konkrit berbitumen. Berikan justifikasi anda kenapa bitumen emulsi ini telah menjadi pilihan.

(4 markah)

    (d)   Campuran konkrit berbitumen AC14 akan digunakan untuk membina lapisan penghausan. Sebelum campuran konkrit berbitumen dihasilkan, pencampuran batu baur perlu dilaksanakan dan harus mematuhi had spesifikasi seperti di dalam Jadual 1. Jadual 2 menunjukkan keputusan ujian ayakan terhadap batu baur yang telah diadun. Buatkan analisis terhadap keputusan ujikaji dan berikan justifikasi samada penggredan batu yang diadunkan memenuhi atau tidak spesifikasi.

(12 markah)

S2   (a)   Senaraikan dan jelaskan **LIMA (5)** keburukan turapan tegar.

(5 markah)

(b)   Sebuah turapan tegar, ada sambungan 'dowel' dan bahu jalan konkrit direkabentuk untuk jalan dua lorong dan dua hala. Beban gandar terkumpul sepanjang masa rekabentuk ditunjukkan di dalam Rajah **Q2.**

Diberi:

Modulus of subgrade reaction (k)   = 40   MPa/m
Concrete Modulus of Rupture (M_R) = 4.5   MPa
Faktor Keselamatan   LSF   = 1.0
Tebal papak   = 240   mm

Dengan menggunakan nomograf dan jadual (kaedah PCA), lengkapkan borang pengiraan seperti di dalam Rajah **Q2**, tentukan:

(i)   Peratus *fatigue*.
(ii)   Peratus *erosion*.
(iii) Bandingkan peratus *fatigue* dan *erosion*, berikan komen dan justifikasi anda.

(20 markah)

S3   (a)   Jelaskan secara terperinci kepentingan menjalankan penyiasatan tapak dalam proses pembinaan jalan raya.

(12 marks)

(b)   Jika jalan raya terpaksa dibina di atas tanah yang lemah, beberapa usaha untuk memperbaiki subgred lemah perlu dilaksanakan. Terangkan secara ringkas **TIGA (3)** usaha tersebut.

(6 markah)

(c)   Pemadatan merupakan proses yang penting dalam penyediaan lapisan permukaan jalan raya.

(i)   Apakah kesan pemadatan terhadap lapisan asfalt?

(2 markah)

(ii)   Sebutkan **DUA (2)** kerosakan turapan yang mungkin berpunca daripada pemadatan yang tidak sempurna.

(2 markah)

(iii) Namakan **TIGA (3)** jenis peralatan pemadatan yang biasanya digunakan dalam pembinaan lapisan asfalt.

(3 markah)

S4 (a) Bandingkan kriteria-kriteria yang diperlukan bagi pemilihan kaedah penyelenggaraan antara kaedah pembinaan semula keseluruhan dan kaedah pembinaan semula separa.

(6 markah)

(b) Berikan **TIGA (3)** faktor yang mempengaruhi pemilihan pengikat untuk merekabentuk *chip* seal.

(3 markah)

(c) Apakah aktiviti yang terkandung di dalam *Pavement Management System (PMS)*.

(4 markah)

(d) Jadual **3** menunjukkan satu tinjauan keadaan turapan untuk sampel unit 17, seksyen JPB-KM2 Jalan Universiti. Dengan menggunakan Rajah **Q4 (a)** dan **Q4 (b)** serta keluasan sampel adalah 600 m^2, lengkapkan Jadual **3**. Sekiranya maksimum *'corrected deduct value'* adalah 65, tentukan *'Pavement Condition Index'* bagi sampel ini.

(12 markah)

S5 (a) Rajah **Q5** menunjukkan struktur turapan boleh anjal terdiri daripada konkrit berasfal pada lapisan pertama dan bahan bergranul untuk lapisan penyaliran. Dengan merujuk kepada Rajah **Q5**:

(i) Namakan **DUA (2)** sumber air bawah permukaan yang bertanda A dan B

(2 markah)

(ii) Berikan **DUA (2)** faktor yang mempengaruhi kuantiti sumber air tersebut.

(4 markah)

(iii) Bolehkah tanah yang beraggregat sangat halus digunakan sebagai lapisan penyaliran dan nyatakan mengapa.

(4 markah)

(iv) Berikan **TIGA (3)** faktor yang mempengaruhi pemilihan saiz dan kedudukan paip di sub lapisan.

(6 markah)

(b) Terangkan secara ringkas bagaimanakah penyelenggaraan permukaan biasanya dilakukan.

(9 markah)

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Table 1: Gradation limits for asphaltic concrete wearing course (AC 14)

BS Sieve Size (mm)	Percentage passing by weight
28.0	
20.0	100
14.0	90 – 100
10.0	76 – 86
5.0	50 – 62
3.35	40 – 54
1.18	18 – 34
0.425	12 – 24
0.150	6 – 14
0.075	4 – 8

Table 2: Sieve analysis test result for blend aggregates

BS Sieve Size (mm)	Mass Retained (g)
28.0	
20.0	0
14.0	440
10.0	625
5.0	1305
3.35	235
1.18	1360
0.425	60
0.150	285
0.075	430
Pan	260

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Calculation of Pavement Thickness

Project
Trial Thickness
Modulus of Rupture, MR
Load Safety factor, LSF   1

Doweled joints :   yes
Conrete shoulder :   yes
Design period :   years

Axle load (kN)	Multiplied by LSF	Expected repetitions	Fatigue analysis		Erosion analysis	
			Allowable repetitions	Fatigue percent	Allowable repetitions	Damage, percent
1	2	3	4	5	6	7

8. Equivalent stress :   10. Erosion factor:
9. Stress ratio factor :

Single Axle

115		15,000				
98		58,150				
89		128,150				
80		167,000				

11. Equivalent stress :   13. Erosion factor:
12. Stress ratio factor :   _____

Tandem Axle

231		12,000				
178		200,000				
160		450,000				
142		500,000				
			Total		Total	

*Note: *Please separate and attach this attachment in your answer script book.*

FIGURE Q2: Rigid Pavement Analysis

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Table 3

JALAN PARIT BOTAK (ASPHALT SURFACED ROAD) CONDITION SURVEY DATA SHEET

BRANCH: TRAFFIC LABORATORY UTHM	DATE: 25 AUGUST 2007
SURVEYED BY: BDD	SAMPLE UNIT: 07
SECTION: JPB-KM2	SAMPLE AREA = 6 m x 100 m

01. Alligator Cracking (m^2)
02. Bleeding (m^2)
03. Block Cracking (m^2)
04. Bumps and Sags (m)
05. Corrugation (m^2)
06. Depression (m^2)
07. Edge Cracking (m)
08. Joint Reflection Cracking (m)
09. Lane/Shoulder Drop Off (m)
10. Longitudinal & Transverse Cracking (m)
11. Patching & Utility Cut Patching ((m^2)
12. Polished Aggregate (m^2)
13. Potholes (no.)
14. Railroad Crossing (m^2)
15. Rutting (m^2)
16. Shoving (m^2)
17. Slippage Cracking (m^2)
18. Swell (m^2)
19. Weathering/ Ravelling (m^2)

	DISTRESS TYPES				
	01	03	11	10	13
	2.5 L	7.8 M	3.1 M	0.8 L	0.5 M
	4.2 L	4.1 M	0.4 M	1.2 L	0.8 M
	1.8 L			0.3 L	
Quantity	6.3 H			0.5 L	
				0.7M	
				1.1M	
				0.4 M	

PCI CALCULATION

DISTRESS TYPE	TOTAL QUANTITY	DENSITY %	DEDUCT VALUE	
01 L				
01 H				
03 M				PCI = 100 − CDV$_{max}$ = _____
10 L				
10 M				RATING = _____
11 M				
13 M				
TOTAL OF DEDUCT VALUE				
CORRECTED DEDUCT VALUE				

Note: *Please separate and attach this attachment in your answer script book.*

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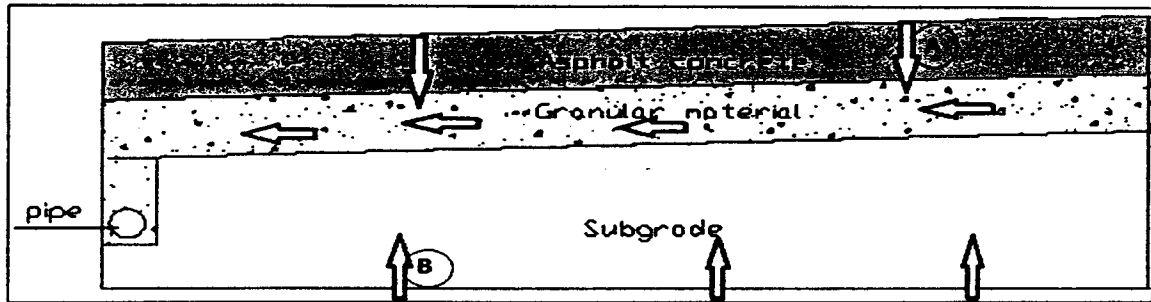COURSE   : HIGHWAY ENGINEERING   COURSE CODE : BFC 3042/BFC 31802

FIGURE Q5: Water sources in flexible pavement

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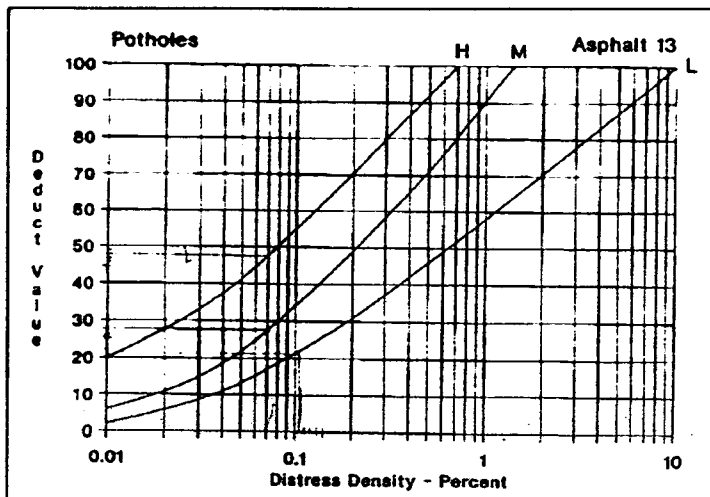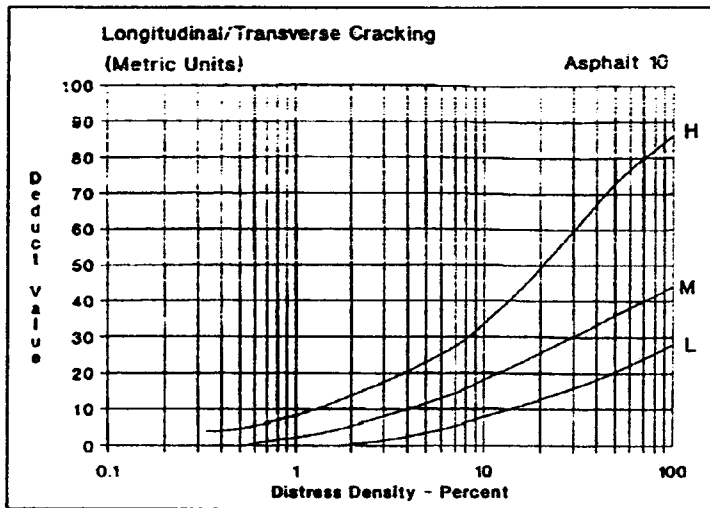COURSE   : HIGHWAY ENGINEERING   COURSE CODE : BFC 3042/BFC 31802

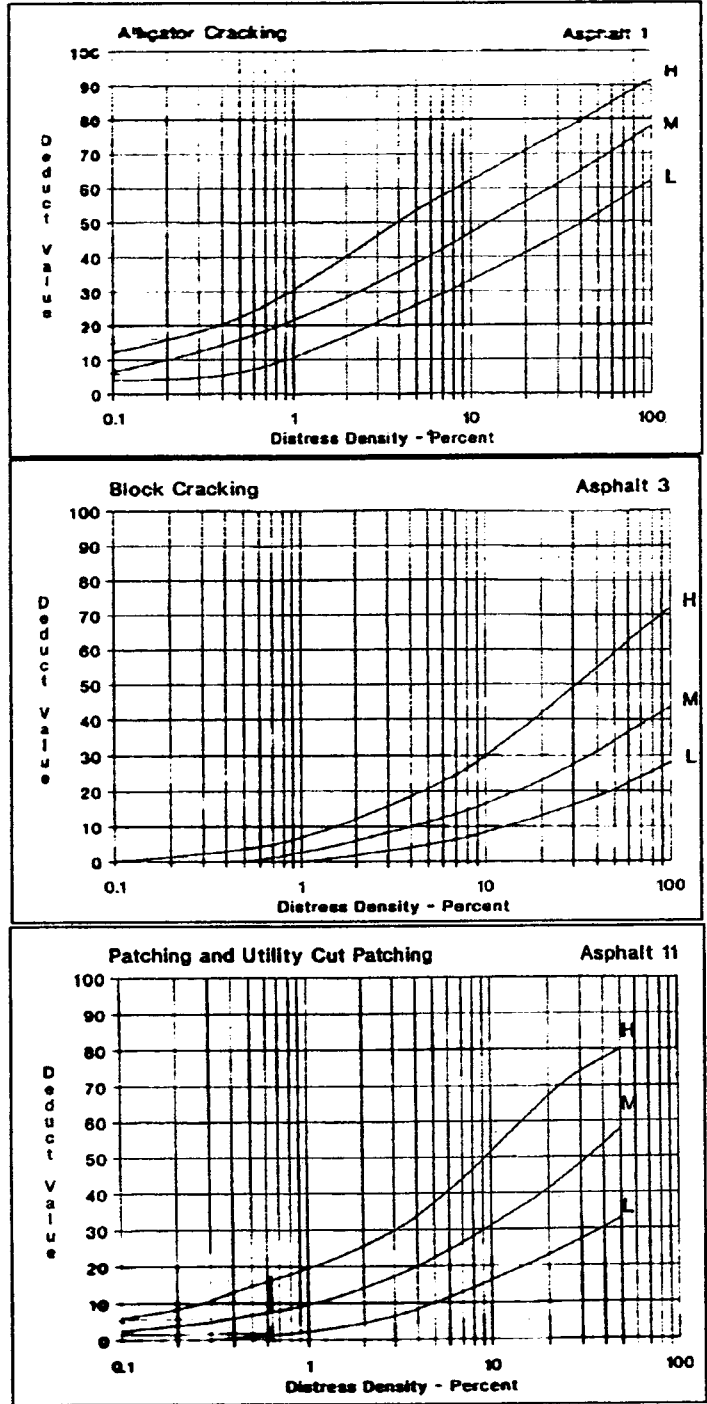FIGURE Q4 (b)

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FIGURE Q4 (a)